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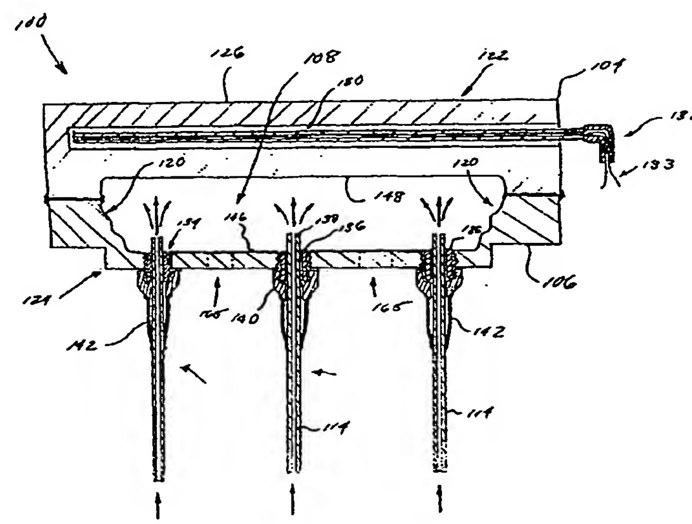

(57) Abstract

A thermal platform for testing and/or conditioning components, having a sealed housing with internal cavity, a plurality of coolant distribution penetrations leading to the cavity, and a plurality of heater elements. A series of identical high pressure coolant lines evenly distribute coolant from a central supply manifold to respective penetrations, the latter forming an array within the bottom of the thermal platform housing. Uniform coolant distribution is further accomplished via nozzles located at the ends of the high pressure lines such that the coolant flowing out of the nozzles impinges directly on the bottom side of the platform top surface. Liquid/gaseous phase coolant is returned to the coolant supply via a series of low-pressure return ports. Precise temperature control of the platform is further maintained through the selective use of the heating elements which are located immediately adjacent to the top surface.

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THERMAL PLATFORM AND METHOD

Background of the Invention

I. Field of the Invention

The present invention relates generally to temperature control devices, and more particularly to precision thermal platforms used for testing and/or conditioning electronic or other components.

II. Description of the Related Technology

Thermal platforms are well known in the component testing and conditioning field. Such platforms are designed to accomplish a variety of testing and conditioning functions, including generally 1) maintaining a uniform temperature (either above or below ambient) of a component for a given period of time; and 2) ramping the temperature of a component up or down at a given rate, often to comparatively extreme temperatures. Such platforms are especially well adapted to conditioning components with flat thermally conductive surfaces (such as silicon wafers or semiconductor die).

Since manufacturer's ratings for such components are in part derived from thermal testing and conditioning, it is essential that the test equipment (in this case the thermal platform) accurately create and maintain the desired temperature profile during testing/conditioning across the entire component or population of components. For example, great economies of scale can be realized by testing or conditioning an entire 8 inch (200 mm) silicon wafer having many distinct die across its width at one time, as opposed to addressing each die individually. However, such economies can only be realized where the thermal platform can maintain sufficient temperature control (e.g., minimal variation) across the entire wafer. A temperature gradient of even a few degrees could potentially result in "overconditioning" or even thermally induced failure of certain die, depending on where and how the temperature is measured. Alternatively, incomplete conditioning or exposure may result for other die. During testing, electrical measurements of the components taken under such circumstances may be inaccurate or not representative of the true performance of the device at the target temperature or rate of temperature change.

Existing prior art thermal platforms have attempted to maintain a desired temperature (or rate of temperature change) with a high degree of accuracy through the combined use of electrical heating elements and cryogenic (or mechanical) refrigeration. However, as shown in the exemplary configuration of Figure 1, such prior art systems have been unable to achieve a highly uniform temperature (e.g., low temperature gradient) across the platform surface due to uneven heating and cooling of this surface. This uneven heating and cooling stems largely from the uneven distribution of coolant (liquid nitrogen, carbon dioxide, or other refrigerant) with respect to the platform test surface. Specifically, as shown in Figure 1, a small number of comparatively large coolant distribution lines have been used, with little consideration as to their placement in relation to the test surface. Furthermore, such lines provide a high coolant flow rate (required to provide the cooling needs of the entire platform/surface area), thereby causing significant temperature gradients throughout the platform due to uneven coolant distribution and thermal lag (e.g., lag time in transferring heat from a remote portion of the platform to a colder region local to a coolant distribution line). The coolant flow rate from such lines is uneven, since the lines are of different lengths, tortuosity, and diameter, thereby resulting in different flow resistances (head loss). Additionally, such prior art distribution lines do not provide for direct impingement or spray of the coolant onto the bottom

of the test surface which helps minimize undesired latency (thermal lag and temperature excursions) and significant spatial temperature gradients.

Based on the foregoing, an improved thermal platform is needed which maintains a high degree of thermal control, e.g., both minimal variation around the desired or target temperature, and controllability during temperature ramping, as well as a minimum temperature gradient across the platform test surface. Such a platform would ideally be of sufficient size and construction to permit the testing or conditioning of a broad array of components.

Summary of the Invention

The present invention satisfies the aforementioned needs by providing an improved thermal platform having a novel coolant distribution and retrieval system and method of operating the same.

In a first aspect of the invention, a thermal platform having a specially shaped internal cavity and plurality of coolant distribution penetrations is disclosed. A series of identical high pressure coolant lines distribute the coolant from a central supply manifold to respective ones of the aforementioned penetrations, the latter forming an array within the bottom of the thermal platform housing so as to distribute coolant evenly to the entire top surface of the platform. Uniform coolant distribution is further accomplished via the ends of the high-pressure lines, which form nozzles within the cavity such that the coolant flowing out of the lines impinges directly on the bottom side of the platform top surface. Liquid/gaseous phase coolant is returned to the coolant supply via a series of low-pressure return ports also located in the bottom of the thermal platform housing. Precise temperature control of the top surface is further maintained through the use of a plurality of heating elements which are immediately adjacent to the top surface.

In another aspect of the invention, a method of maintaining a highly uniform temperature across the top surface of the aforementioned thermal plate is disclosed. Coolant is injected into the cavity of the platform using the array of high-pressure distribution lines at a rate determined by a temperature controller, while one or more of the heating elements are energized in order to maintain the platform temperature (or rate of temperature increase/decrease) constant.

Brief Description of the Drawings

Figure 1 is a perspective view of a prior art thermal platform.

Figure 2a is an exploded bottom perspective view of a first embodiment of the thermal platform of the present invention, showing the upper and lower housing elements, plurality of coolant distribution and return lines, and heater elements.

Figure 2b is a detail perspective view of a high pressure distribution line nozzle fitting installed on the thermal platform of Figure 2a.

Figure 2c is a bottom plan view of the array of coolant distribution and return penetration in the bottom plate of the thermal platform of Figure 2a.

Figure 3 is a cross-sectional view of the thermal platform of Figure 2a (fully assembled) taken along line 3-3.

Figure 4 is a cross-sectional view of the coolant distribution manifold of the thermal platform of Figure 2a.

Figure 5a is bottom perspective view of a second embodiment of the thermal platform of the present invention having a cylindrical housing.

Figure 5b is plan view of the bottom plate of the thermal platform of Figure 5a showing the relative location of the coolant distribution and return penetrations.

Figure 5c is a plan view of the top surface of the thermal platform of Figure 5a, showing the relative locations of the radial heater element recesses.

Figure 6a is a bottom perspective view of a third embodiment of the thermal platform of the present invention.

Figure 6b is a plan view of the top surface of the thermal platform of Figure 6a, showing the relative location and angle of the coolant nozzles.

Detailed Description of the Preferred Embodiments

Reference is now made to the drawings wherein like numerals refer to like parts throughout.

Description of Thermal Platform Apparatus

A first embodiment of the thermal platform of the present invention is shown in Figure 2a. The thermal platform 100 is comprised in part of a housing 102 which consists of two housing elements, e.g., upper housing element 104, which has a flat upper surface (not shown), and lower housing element 106, which has a flat lower surface. These elements 104, 106 are mated together (as described further below) to form a sealed interior cavity 108. Although square in cross-section in the present embodiment, it can be appreciated that the shape and size of the housing 102 (including, inter alia, the depth of the cavity 108 and the number of individual housing elements 104, 106) may be varied depending on the particular application. See, for example, the discussion of Figures 5a-5c and 6 below. A plurality of penetrations 134 are provided in array fashion (Figure 2b) in the bottom surface 112 of the lower housing element 106 to permit the insertion of high pressure coolant distribution lines 114 therein. The coolant lines 114 are of equal length, diameter, and construction so as to provide essentially identical coolant flow to the various penetrations 134. The lines 114 are further connected to a common distribution manifold 116 which ports high pressure coolant from a coolant source (not shown) to each of the distribution lines 114. Each of the cooling lines 114 is mated to the lower housing element 106 via a threaded compression fitting 136, 140 (Figure 2c) or any suitable joint which permits leak-tight coolant flow. Note that while the present embodiment utilizes a total of twelve (12) high pressure lines 114 and associated penetrations, any number of lines and penetrations which accomplish the desired level of temperature uniformity and control within the platform 100 may be used.

Referring now to Figure 3, the embodiment of Figure 2 is described in additional detail. The upper and lower housing elements 104, 106 are comprised of walls 120 which bound the cavity 108 on its sides, as well as an upper (top) plate 122 and lower (bottom) plate 124 which bound the cavity from above and below, respectively. The cavity shape and dimensions are preferably chosen so as to provide a suitable cavity volume (and refrigerant mass) as well as the most efficient and uniform heat transfer from the top plate 122 to the coolant. In the present embodiment, the cavity cross-sectional shape matches that of the top plate (e.g., square) for this reason. The top plate 122 has an upper surface 126 which is substantially planar (flat) in the present embodiment and sized so as to permit the maximum degree of physical contact between the components to be tested and the upper surface. Furthermore, the top plate 122 has a number of elongated cylindrical recesses 130 formed therein and oriented parallel to the upper surface 126 for receiving one or more

heater elements 132 (described further below). The bottom plate 124 and top plate 122 are substantially parallel to one another as well, as shown in Figure 3.

Both the upper and lower housing elements 104, 106 (including the walls 120, top plate 122, and bottom plate 124) in the embodiment of Figures 2 and 3 are preferably constructed from a highly thermally conductive metal. One preferred material is aluminum alloy due to its comparatively light weight, good thermal response and stability, and ease of machining; however, other materials having desirable properties may be substituted. Small surface ridges or diffusion patterns (see Figure 2a) on the inner surfaces 125 of the housing elements 104, 106 can optimally be used to increase the surface area of the plates 122, 124 and aid in refrigerant diffusion so as to make heat transfer more efficient.

Referring again to Figure 3, the mating surfaces 126 of the upper and lower housing elements 104, 106 are machined to permit a smooth, uniform fit and to facilitate sealing. In the present embodiment, the upper and lower elements 104, 106 are welded together to form a seal between the walls 120 of each, although it can be appreciated that other methods of joinder and sealing (such as brazing, threaded fasteners with gaskets, external mechanical clamping arrangements, and adhesives) may be used with equal success. A plurality of threaded penetrations 134 are machined into the bottom plate 124 of the lower housing element 106 to receive threaded compression fitting studs 136. These studs 136 act to guide the nozzle portions 138 of the high pressure lines 114 through the penetrations 134 and align them properly when the platform 100 is assembled. A compression fitting cap 140 threadedly engages each respective stud 136, and captures the line shroud 142 between the inner surface of the cap 140 and the end of the stud 136 so as to form a leak-tight compression fit between the cap 140, stud 136 and shroud 142 when the cap 140 is mechanically tightened. The line shroud 142 is further welded or brazed to its respective high pressure line 114 to complete the seal between the cavity 108 and the atmosphere. An elastomeric or polymer thread sealant (such as LOCKTITE™ brand sealant or TEFLON™ tape) may be used if desired to ensure the adequacy of the seal between the threads of each stud 136 and its respective penetration 134.

When the high pressure lines 114 and associated nozzles 138 are assembled into the bottom plate 124 as shown in Figure 3, the nozzles 138 protrude somewhat above the upper surface 146 of the lower plate 124, and are oriented vertically within the cavity 108 so as to impinge coolant directly onto the lower surface 148 of the top plate 122 if desired. The nozzles 138 in the present embodiment are constructed by simply continuing the high pressure lines 114 into the cavity 108, although it can be appreciated that other nozzle configurations (such as an orifice of different diameter than that of the associated high pressure line 114) may be used to accomplish the desired functions of coolant distribution and spray. Note also that the present invention contemplates the use of nozzles 138 of varying height within the cavity 108 to effect more even coolant distribution under certain circumstances, such as where the lower surface of the top plate 122 is curved or of irregular shape.

Also attached to the bottom plate 124 of the lower housing element 106 are a plurality of low-pressure coolant return lines 164 (shown in Figure 2). These lines are larger in diameter than the high-pressure lines to reduce flow resistance (head loss). These return lines are attached to the lower element 106 via standard pipe or compression fittings (such as those previously described) which are installed in a series of perforations 165 located at the gravity low point of

the platform. This location facilitates the return or disposal of liquid coolant which collects on the top surface 146 of the bottom plate 124 within the cavity 108. Furthermore, since the coolant lines are maintained at a substantially lower pressure than the high pressure distribution lines 114, manifold 116, and coolant source, gaseous or mixed-phase coolant naturally flows from the high pressure lines 114 (and associated nozzles 138) into the cavity 108, where it impinges upon the upper plate lower surface 148 and ultimately flows out the return lines 164.

Further shown in Figure 3 are the heater elements 132 used to elevate the temperature of the top surface 126 of the test platform 100. In the present embodiment, electrical (resistive) direct current heater elements are used, such as the Model J97-25 manufactured by Tempco. These heater elements 132 are connected via their electrical leads 133 to an electrical power supply (not shown) via control logic which selectively energizes or de-energizes the elements 132. This type of heater element is chosen due to its comparatively high heat generation capacity (thermal power output), thermal stability, and linearity. The heater elements 132 are installed within respective recesses 130 in the upper housing element 104, and transfer heat energy to the upper housing element 104 and upper surface 126 via conductive, radiative, and to a lesser degree convective heat transfer. However, it will be apparent to one of ordinary skill in the art that any number of different alternative heating devices and methods may be used to elevate the temperature of the platform top surface 126. For example, fluidic heaters (i.e., headers carrying a comparatively higher temperature fluid) or even laser energy could be used to supply heat to the top surface 126 in a controlled fashion.

Referring now to Figure 4, a cross-section of the coolant distribution manifold 116 is shown. The manifold is comprised generally of a hollow cylindrical threaded metallic fitting 150 with a plurality of apertures 152 in the discharge end 154 of the fitting 150. A plurality of high pressure lines 114 terminate at respective apertures 152 in the fitting 150, where the lines 114 are individually joined to the fitting 150 via conventional welding or brazing techniques. The fitting 150 is then joined via the threads 156 on the fitting to a high pressure liquid or gaseous coolant source (such as a cryogenic liquid nitrogen or carbon dioxide rig, or alternatively a freon- or even ammonia-based refrigeration system) which supplies coolant to the manifold 116 and ultimately the test platform cavity 108 via the high pressure lines 114.

Figures 5a-5c illustrate a second embodiment of the thermal platform of the present invention. Referring to Figure 5a, a housing 102 of circular cross-section and generally cylindrical shape is shown. Such a cylindrical shape is especially well suited to testing and conditioning silicon wafers. The housing 102 is comprised of upper and lower housing elements 104, 106 each having a hollowed cylindrical cavity open at one end. When the upper and lower housing elements 104, 106 are mated together as shown in Figure 5a, a single, fully enclosed cylindrical cavity 108 is formed. The upper and lower elements 104, 106 are sealed via welding, brazing, or other comparable techniques previously described.

As shown in Figure 5c, a number of heater element recesses 130 are created radially (e.g., arranged in a spoke-like manner relative to the central longitudinal axis 160 of the platform housing 102 in a plane parallel to the top surface 126 of the platform) within the upper portion of the upper housing element 104 above the cavity 108 to house the heater elements.

Referring again to Figure 5a, each of the nozzles 138 associated with the high pressure distribution lines 114 project vertically upward into the cavity to a height suitable to ensure adequate coolant distribution within the cavity (and impingement of coolant upon the underside of the top plate 122, not shown.)

Figures 6a and 6b show a third embodiment of the thermal platform of the present invention. The two-piece cylindrical housing 102 (with internal cavity 108) of the embodiment of Figure 5a above is generally used; however, a series of threaded nipples 170 are formed around the periphery 172 of the upper housing element 104 to receive respective high pressure distribution lines 114. The nipples 170 project generally inward toward the longitudinal axis 160 of the housing 102 in the horizontal plane (e.g., in the plane parallel to the top surface 126), but are canted at an angle θ (θ being equal to 30 degrees from the radial direction in this embodiment, as shown in Figure 6b) for more uniform coolant distribution. In the vertical plane, the nipples 170 are oriented at a similar angle such that the nozzles 138 spray coolant directly on the underside of the top plate 122 at an oblique angle. While 30 degrees has been chosen for the cant angle in both the vertical and horizontal planes in the present embodiment, it can be appreciated that other angles (and combinations thereof) may be used with equal success.

As in the other embodiments, the high pressure lines 114 of the thermal platform of Figures 6a-6b are mounted to the nipples 170 using standard threaded compression fittings 136, 140, and are of equal length from the manifold 116 to ensure uniform coolant flow to each portion of the cavity 108. Furthermore, the radial heater element arrangement of the embodiment of Figure 5c is utilized wherein the heater element recesses 130 are interspersed with the nipples 170 such that the coolant sprays into the interstitial areas on the bottom surface of the top plate 122, thereby allowing for uniform heat and coolant distribution. The embodiment of Figure 6 has the advantage of having a somewhat lower overall height than the embodiment of Figures 5a-5c, although the radial size (i.e., diameter) is increased somewhat.

Method of Operation

Referring again to Figure 2a, the thermal platform apparatus 100 disclosed above is constructed in such a manner as to maintain a high degree of temperature uniformity across the top surface 126. Additionally, it is desirous for the platform to be able to rapidly raise and lower the top surface temperature in a controlled and predictable fashion, again maintaining a high degree of uniformity across the top surface 126 at any given time. To accomplish these aims, the temperature of the platform is monitored and controlled (via a closed PID loop or other suitable control mechanism) such that the flow of coolant into the cavity 108 via the distribution line nozzles 138 and energization of the heater elements 132 maintains the platform top surface temperature (or rate of increase/decrease) within a narrow band. In the case of a steady-state temperature, the heater elements 132 are periodically energized or coolant periodically admitted into the cavity (depending on the desired platform temperature and existing ambient temperature) to maintain the desired value. Coolant flow is adjusted by altering the pressure drop (such as with a valve or variable orifice) between the coolant source (not shown) and the distribution manifold 116. In the case of temperature ramping (e.g., programmed temperature increases or decreases over a given time interval), the heaters 132 are energized and/or coolant is admitted to maintain the rate of temperature change effectively constant until the desired platform temperature is reached. Input to the heater/coolant control circuitry is accomplished via one or more external thermocouples or resistance temperature

detectors (RTDs) of the type well known in the art (not shown), which are mounted directly onto or within the top surface 126 of the platform.

While the above detailed description has shown, described, and pointed out fundamental novel features of the invention as applied to various embodiments, it will be understood that various omissions, substitutions, and changes in the form and details of the devices illustrated may be made by those skilled in the art without departing from the spirit of the invention.

WHAT IS CLAIMED IS:

1. A thermal platform, comprising:

a housing having;

walls and an upper plate;

a cavity formed within said housing, said cavity bounded by said walls and said upper plate;

at least one heating element disposed in substantial proximity to said upper plate;

a coolant source for providing coolant at a pressure greater than that of said cavity;

a plurality of coolant distribution lines penetrating said housing for distributing coolant from said coolant source within said cavity; and

at least one coolant return line for discharging said coolant from said cavity.

2. The thermal platform of Claim 1, wherein said housing is substantially rectangular in cross-section.

3. The thermal platform of Claim 1, wherein said coolant distribution lines include nozzles such that said coolant flowing from said lines into said cavity impinges on an interior surface of said planar upper plate.

4. The thermal platform of Claim 3, wherein said nozzles protrude above the inner surface of at least one of said walls.

5. The thermal platform of Claim 3, wherein said nozzles penetrate said housing such that the distribution of coolant within said cavity is substantially uniform.

6. The thermal platform of Claim 1, wherein said housing is further comprised of upper and lower housing elements.

7. The thermal platform of Claim 6, wherein said upper and lower housing elements are welded together to form a pressure-tight seal for said cavity.

8. The thermal platform of Claim 1, wherein said heating elements are disposed within respective recesses within said housing.

9. The thermal platform of Claim 1, wherein said heating elements are electrical resistive heating elements.

10. The thermal platform of Claim 1, wherein said coolant is a refrigerant.

11. The thermal platform of Claim 10, wherein said coolant source includes a compressor and cooler.

12. The thermal platform of Claim 1, wherein said coolant is taken from the group consisting of liquid nitrogen and carbon dioxide.

13. The thermal platform of Claim 1, wherein said coolant flow through individual ones of said coolant distribution lines is varied in order to maintain precise control of the temperature gradient across said upper plate.

14. A thermal platform housing, comprising:

a housing body having walls and a top plate, said top plate which is at least in part substantially planar, said walls and top plate each having interior and exterior surfaces;

a cavity disposed entirely within said housing body, said cavity bounded by said interior surfaces of said walls and said top plate;

a plurality of penetrations through at least one of said walls and communicating with said cavity, said penetrations arranged so as to allow substantially uniform distribution of coolant within said cavity by coolant distribution nozzles installed within said penetrations.

15. The thermal platform housing of Claim 14, wherein said housing further includes at least one recess in substantial proximity to said top plate for enclosing one or more heater elements.

16. The thermal platform housing of Claim 15, wherein said penetrations are further arranged to allow impingement of said coolant flowing from said nozzles directly against said interior surface of said top plate.

17. A method of controlling the temperature of a thermal platform, wherein said thermal platform includes a housing having at least one heater element, a substantially planar top plate, and cavity disposed therein, comprising the steps of:

providing a plurality of coolant distribution lines connecting a coolant distribution manifold to a plurality of penetrations in said housing;

selectively providing coolant at a pressure higher than that existing in said cavity to said manifold in order to induce uniform flow and distribution of said coolant from said manifold into said cavity;

selectively energizing said heaters;

said directing of coolant flow and energization of heaters being performed in response to a signal related to the temperature of said top plate so as to control said temperature as desired.

18. The method of Claim 17, wherein said coolant distribution lines are substantially similar in construction and substantially equal in length.

19. The method of Claim 18, wherein said coolant distribution lines include nozzles for spraying said coolant into said cavity.

20. The method of Claim 17, wherein said signal is derived from a closed loop control circuit.

21. The method of Claim 17, wherein said step of selectively providing coolant comprises spraying coolant from said plurality of coolant distribution lines to impinge against a surface of said top plate located within said cavity.

22. A method for controlling the temperature of a thermally conductive plate that has top and bottom surfaces, comprising the steps of:

automatically directing substantially equivalent volumes of cooling fluid through a plurality of equally sized coolant lines of uniform length;

cooling said plate by spraying said cooling fluid from said coolant lines to impinge against said bottom surface of said plate in a uniform pattern; and

automatically heating the plate by simultaneously applying identical heating energy to uniformly spaced areas of said plate.

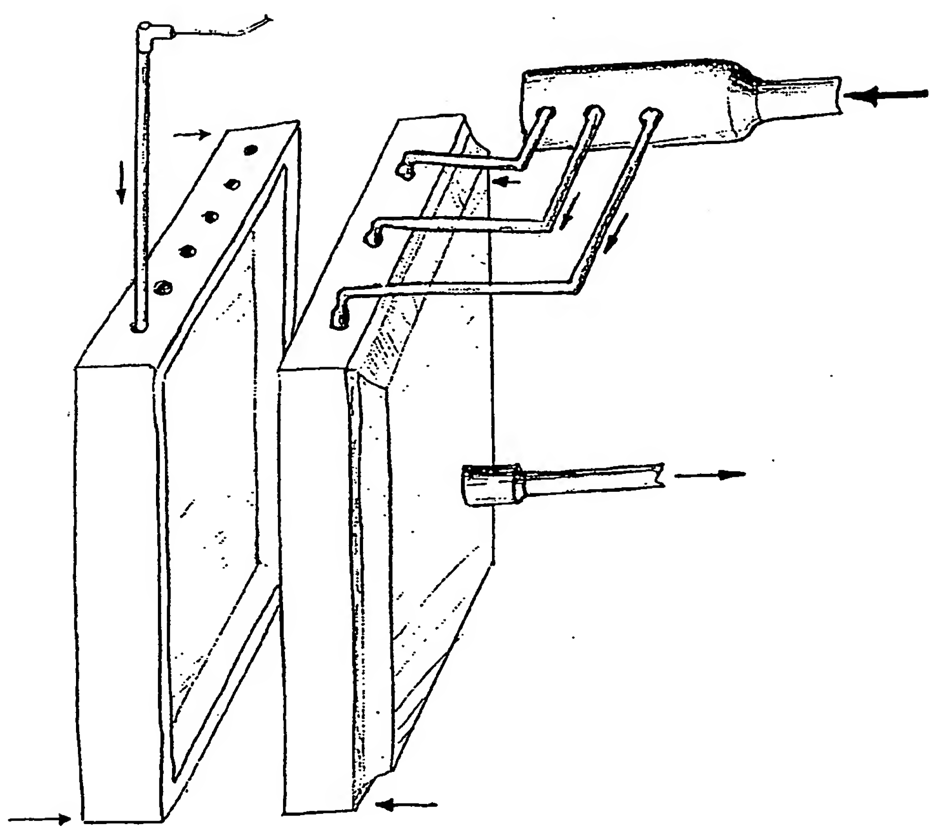
23. The method of Claim 22, wherein said cooling fluid is sprayed against the bottom surface of said plate in a cavity located adjacent to said bottom surface.

24. The method of Claim 22, further comprising the steps of:

monitoring the temperature of said plate, and

controlling the heating and cooling of said plate responsive to said monitoring step.

FIG. 1
(PRIOR ART)



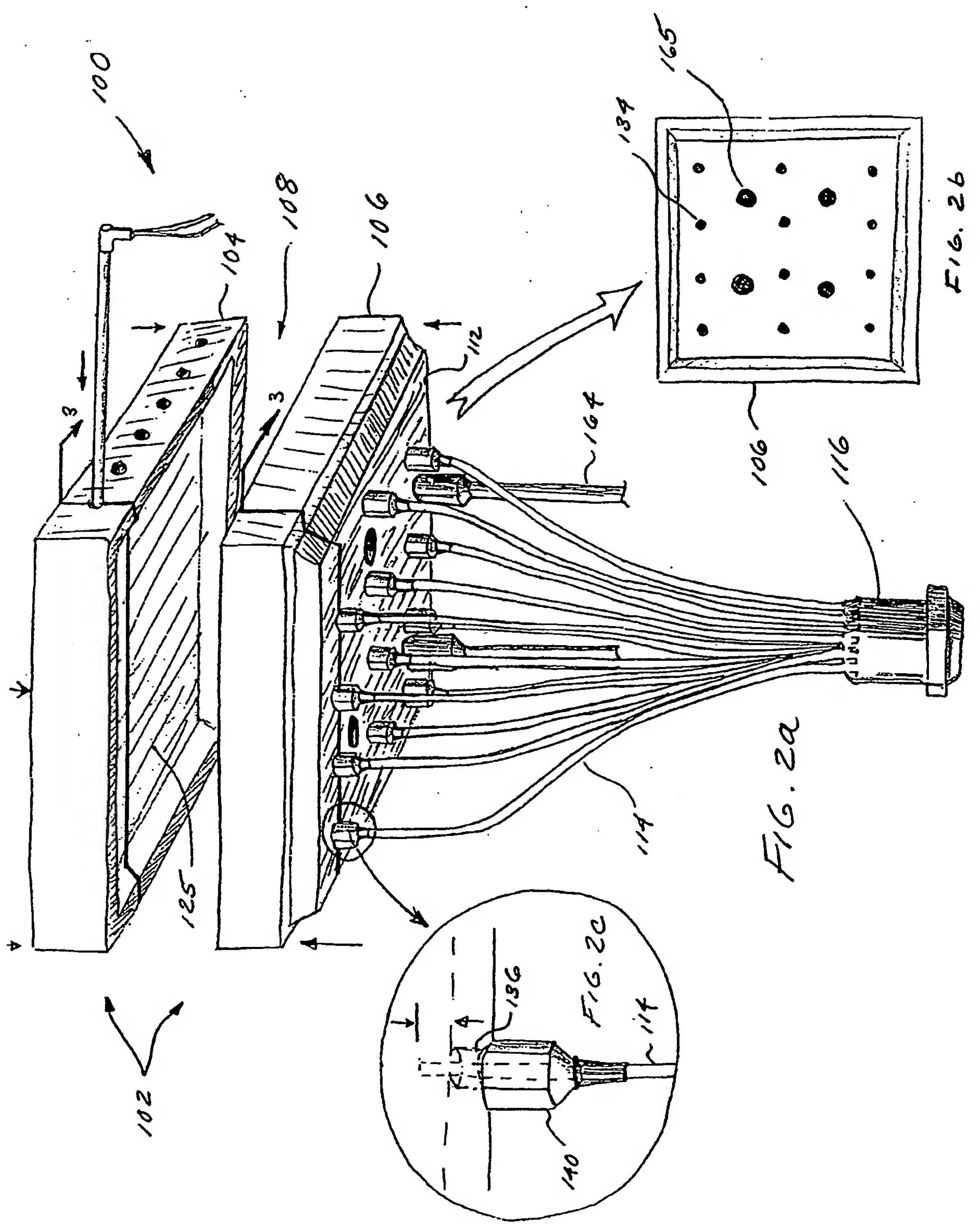

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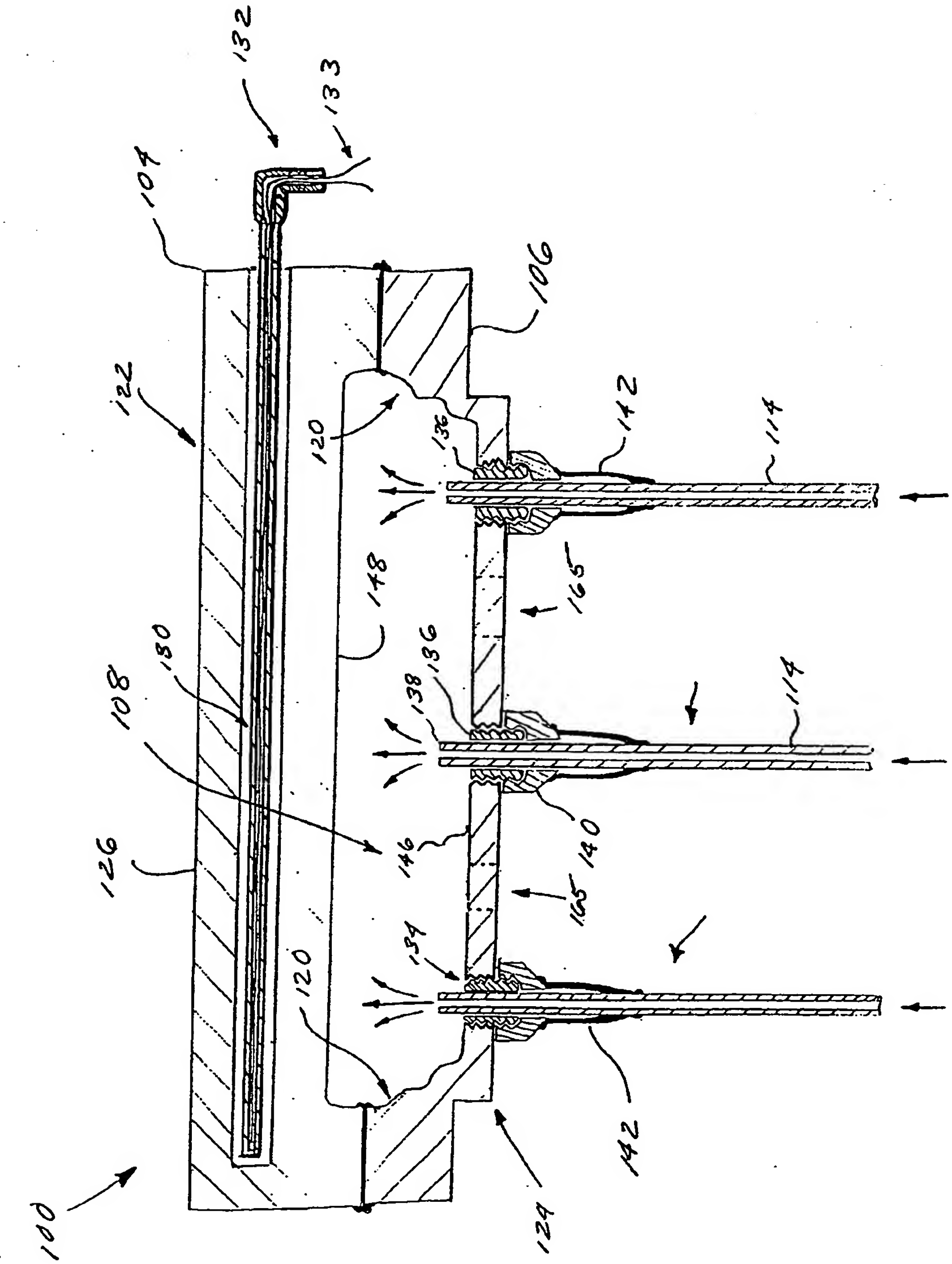
FIG. 2a
FIG. 2b
FIG. 2c

FIG. 3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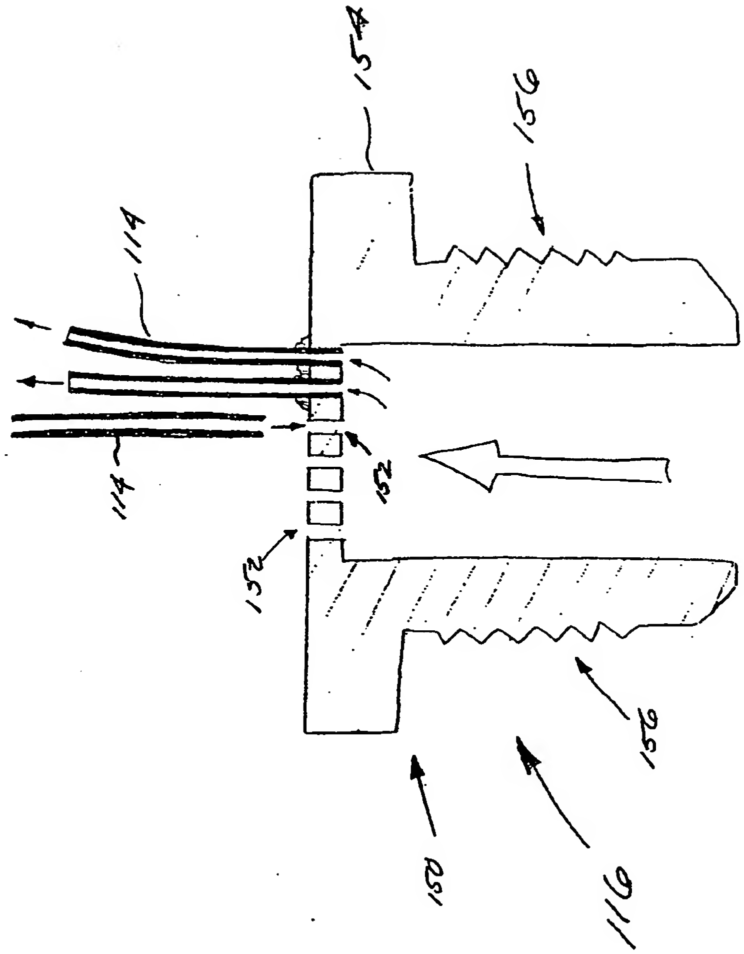

FIG. 4

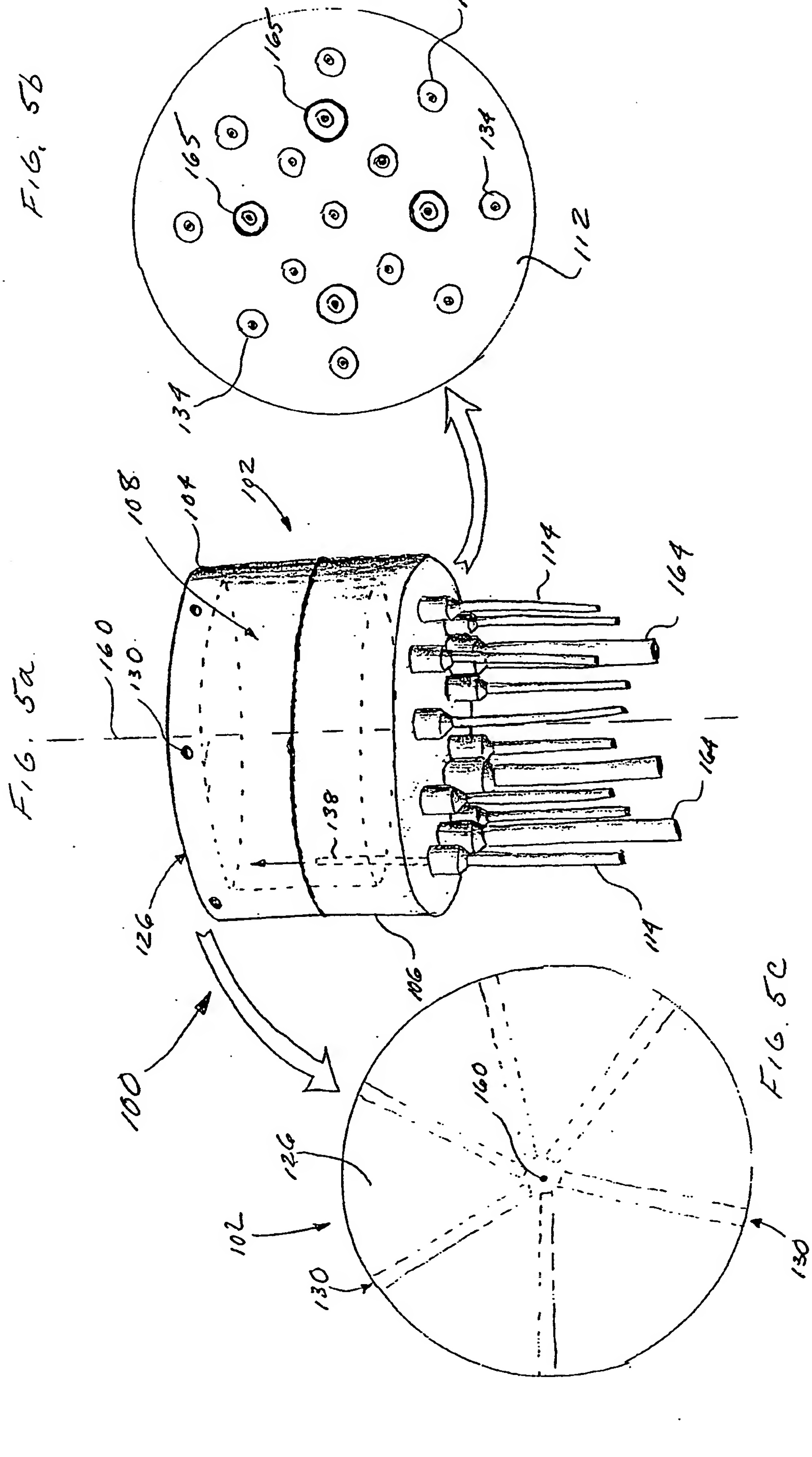
FIG. 5b
FIG. 5a
FIG. 5c
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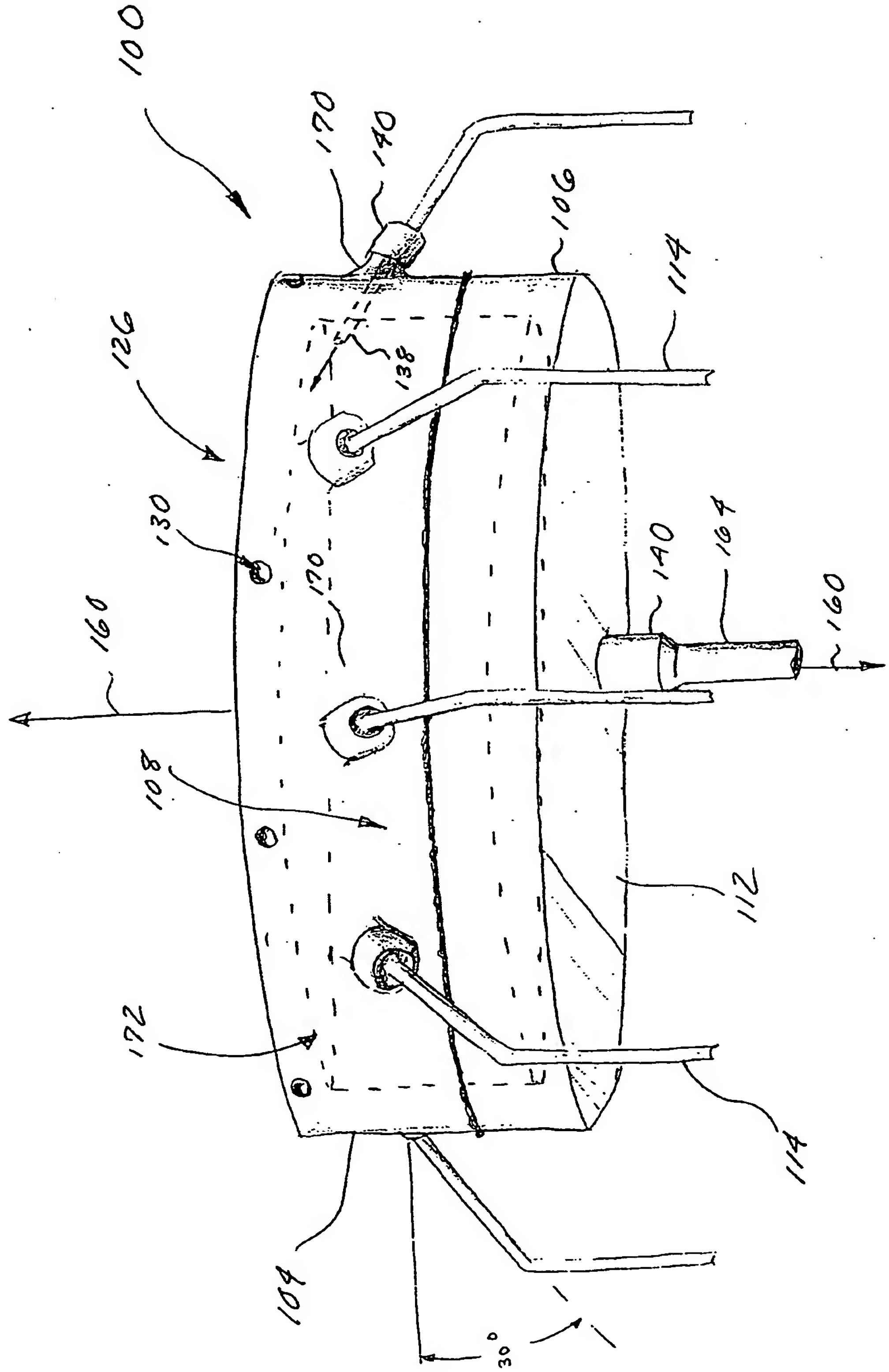
FIG. 6a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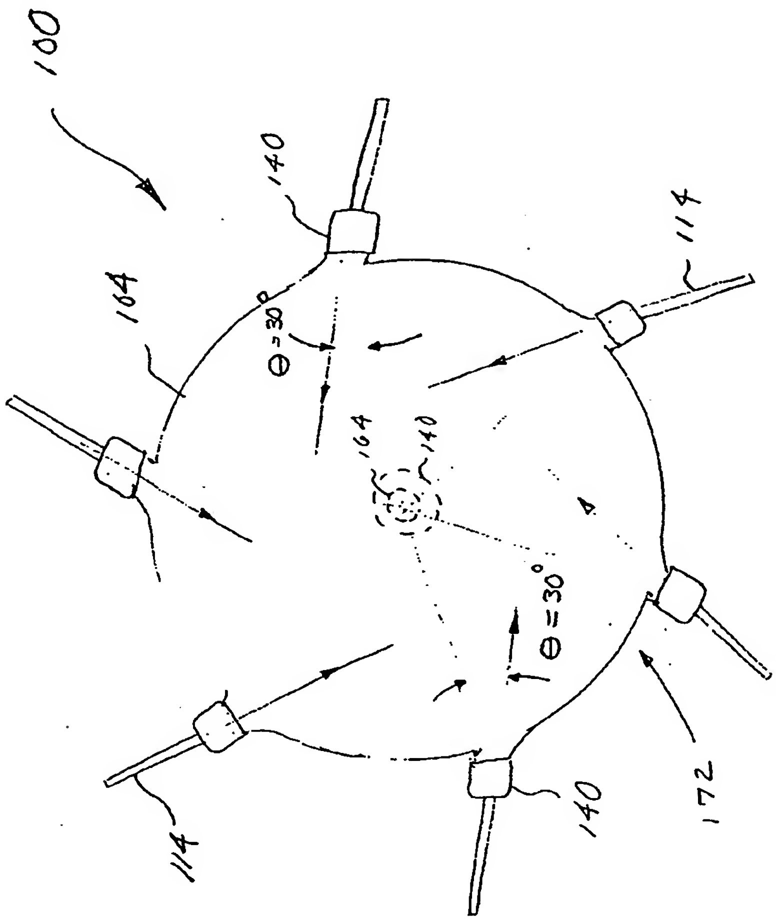

FIG. 6B

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/15609

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01R31/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 5 278 495 A (BEATON ET AL.) 11 January 1994 (1994-01-11) figure 1 ---	1,10,14, 17,18,20 2,5,9, 11,12,15
Y	FR 2 227 537 A (LAB. CENTRAL DES IND. ÉLECTRIQUES1) 22 November 1974 (1974-11-22) claim 1 ---	2
Y	DE 19 49 714 A (SCHNELLE) 25 February 1971 (1971-02-25) figure 1 ---	2,5,9, 11,12
Y	US 5 451 884 A (SAUERLAND) 19 September 1995 (1995-09-19) figures 1-3 -----	15

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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Date of the actual completion of the international search: 10 November 1999

Date of mailing of the international search report: 16/11/1999

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 99/15609

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5278495 A	11-01-1994	NONE	
FR 2227537 A	22-11-1974	NONE	
DE 1949714 A	25-02-1971	NONE	
US 5451884 A	19-09-1995	JP 7167905 A	04-07-1995